OXFORD AQA
INTERNATIONAL QUALIFICATIONS

INTERNATIONAL A LEVEL
FURTHER MATHEMATICS

Further Mechanics 2

Specimen paper 0X:00 GMT Time allowed: 1 hour 15 minutes

Materials
- For this paper you must have the OxfordAQA Pure Mathematics and Mechanics Examination Booklet (enclosed)
- You may use a graphical calculator.

Instructions
- Use black ink or black ball-point pen. Pencil should only be used for drawing.
- Fill in the boxes at the top of this page.
- Answer **all** questions.
- You must answer the questions in the spaces provided. Do not write outside the box around each page or on blank pages.
- If you need extra space for your answer(s), use the lined pages at the end of this book. Write the question number against your answer(s).
- Do all rough work in this book. Cross through any work you do not want to be marked.
- The **final** answer to questions requiring the use of calculators should be given to **three** significant figures, unless stated otherwise.
- The magnitude of the acceleration due to gravity, g, should be taken as 9.8 m s^{-2}

Information
- The marks for questions are shown in brackets.
- The maximum mark for this paper is 60.

Advice
- Unless stated otherwise, you may quote formulae, without proof, from the booklet.
- Show all necessary working; otherwise, marks may not be awarded.

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There are no questions printed on this page

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ANSWER IN THE SPACES PROVIDED

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Answer **all** questions in the spaces provided.

1 A particle is initially at rest at the point O on a horizontal surface.

A horizontal force of magnitude F newtons and constant direction starts to act on the particle.

When the displacement of the particle from O is x metres, F is given by

$$F = 6e^{-0.1x}$$

The particle passes through the point A which is 8 metres from O

The work done by the force as the particle moves from O to A is W joules.

Show that $W = 33.0$ correct to three significant figures.

[3 marks]

Turn over for the next question

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2 Two particles A and B are moving on a smooth horizontal surface.

The two particles collide.

Particle A has mass 3 kg and before the collision has velocity $\begin{bmatrix} 2 \\ 9 \end{bmatrix}$ m s^{-1}

Particle B has mass 8 kg and before the collision has velocity $\begin{bmatrix} 5 \\ -4 \end{bmatrix}$ m s^{-1}

After the collision particle A has velocity $\begin{bmatrix} 6 \\ 1 \end{bmatrix}$ m s^{-1}

2 (a) Find the velocity of B after the collision.

[3 marks]

Answer _____

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2 (b) Find the magnitude of the impulse exerted on A by B during the collision.

Give your answer in exact form.

[3 marks]

Answer _____

Turn over for the next question

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3 A ball of mass 0.2 kg falls vertically from rest.

The ball experiences an air resistance force as it falls.

The air resistance force has a magnitude $\frac{v}{8}$ newtons when the speed of the ball is v m s^{-1}

The ball hits the ground when it has been falling for 11 seconds.

Find the speed at which the ball hits the ground.

[6 marks]

Answer _____

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4 A finite region is bounded by the curve with equation $y = 9 - x^2$, the y-axis and the x-axis for $x \geq 0$

The region is rotated through 360° around the x–axis to form a uniform solid.

The centre of mass of the solid is located at $x = d$ where d is a constant.

Find the value of d

Give your answer in an exact form.

[5 marks]

$d =$ _____

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5 A small toy car has mass m kg

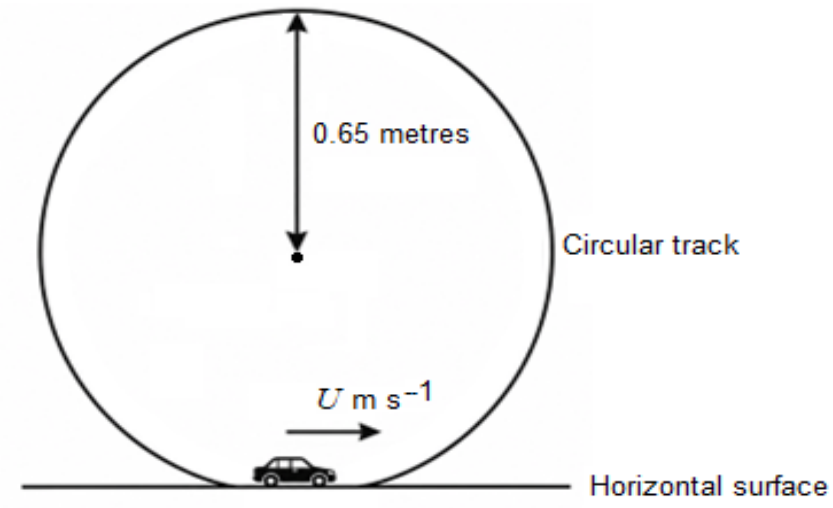
A smooth circular track is fixed to a horizontal surface so that the plane of the track is vertical.

The track has a radius of 0.65 metres.

The car is placed at the lowest point on the circular track and is set into motion with speed U m s^{-1} along the track.

Figure 1 shows the initial velocity of the car and the smooth circular track fixed to the horizontal surface.

Figure 1



The car moves around the complete circular track without losing contact with the track.

Find the smallest possible value of U

Give your answer in exact form in terms of g

[5 marks]

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Answer _____

Turn over for the next question

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6 A particle moves with simple harmonic motion on a straight line.

The particle has its maximum speed at the point O

The points A and B lie on the line.

At A the displacement of the particle from O is -3 metres and its speed is 4 m s^{-1}

At B the displacement of the particle from O is 2 metres and its speed is 6 m s^{-1}

6 (a) Find the amplitude of the motion.

Give your answer in an exact form.

[5 marks]

Answer _____

6 (b) Find the period of the motion.

Give your answer in an exact form.

[3 marks]

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Answer _____

6 (c) Find the shortest time that it takes for the particle to move from A to B

[4 marks]

Answer _____

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7 A plane is inclined at an angle of 20° to the horizontal.

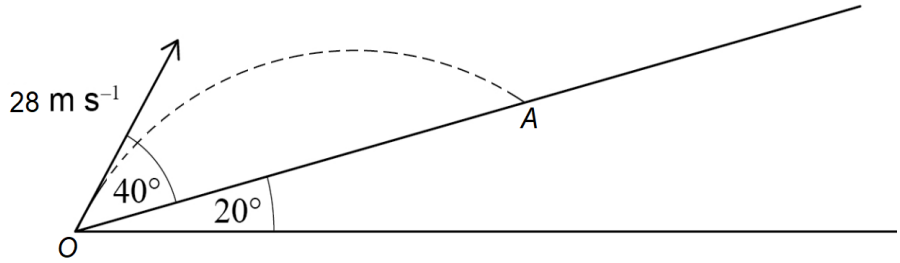
A ball is projected from a point O on the plane.

The ball hits the plane at a point A which is further up the plane.

The line OA is a line of greatest slope of the plane.

The initial velocity of the ball is 28 m s^{-1} at an angle of 40° to the plane, as shown in **Figure 2**

Figure 2



Assume that the ball experiences no air resistance.

7 (a) Find the maximum distance of the ball from the plane.

[4 marks]

Answer _____

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7 (b) The acute angle between the velocity of the ball and the plane when the ball hits the plane at A is θ

Find the angle θ

Give your answer to the nearest degree.

[7 marks]

$\theta =$ _____

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8 Two smooth spheres A and B of equal radii are moving on a horizontal surface when they collide.

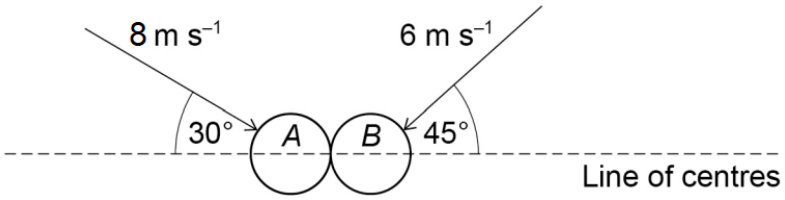
The mass of A is 4 kg and the mass of B is 2 kg

As the spheres collide:

- sphere A has a velocity of 8 m s^{-1} at an angle of 30° to the line of centres
- sphere B has a velocity of 6 m s^{-1} at an angle of 45° to the line of centres.

The velocities of the spheres as they collide are shown in **Figure 3**

Figure 3



The coefficient of restitution between the two spheres is e

It is given that $e \geq \frac{2}{3}$

8 (a) Find the range of possible speeds of A after the collision.

Give your answers to two decimal places.

[8 marks]

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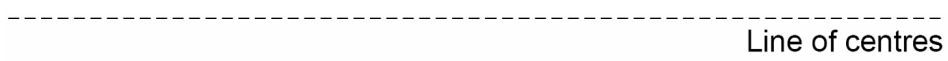
Answer

8 (b) On **Figure 4** show the range of possible directions of motion of A after the collision.

Give any angles you calculate to the nearest degree.

[4 marks]

Figure 4



END OF QUESTIONS

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